RS-002, "PROCESSING APPLICATIONS FOR EARLY SITE PERMITS"

ATTACHMENT 2

2.4.12 GROUNDWATER

REVIEW RESPONSIBILITIES

Primary - Mechanical and Civil Engineering Branch (EMEB)

Secondary - None

I. AREAS OF REVIEW

For review of an early site permit (ESP) application, data presented in the applicant's site safety assessment on local and regional groundwater reservoirs are reviewed to establish the effects of groundwater on foundations of a nuclear power plant or plants of specified type (or falling within a plant parameter envelope [PPE]) that might be constructed on the proposed site. Other areas reviewed under this section of this review standard include identification of the aquifers and the type of onsite groundwater use, the sources of recharge, present and future withdrawals, monitoring and protection requirements, design bases for groundwater levels, and hydrodynamic effects of groundwater on safety-related structures and components (the last of these being an item for the combined license [COL] stage). Flow rates, travel time, gradients, other properties pertaining to the movement of accidental contamination, and groundwater levels beneath the site are reviewed, as are seasonal and climatic fluctuations, or those caused by man, that have the potential for long-term changes in the local groundwater regime.

II. ACCEPTANCE CRITERIA

Acceptance criteria for this section of this review standard relate to the following regulations:

1. 10 CFR Parts 52 and 100 (Refs. 1 and 2) require that hydrologic characteristics be considered in the evaluation of the site.

2. 10 CFR 100.23 sets forth the criteria to determine the suitability of design bases for a nuclear power plant or plants of specified type (or falling within a PPE) that might be constructed on the proposed site with respect to seismic characteristics of the site. It also requires that the adequacy of the cooling water supply for emergency and long-term shutdown decay heat removal be ensured, taking into account information concerning the physical, including hydrological, properties of the materials underlying the site.

As specified in 10 CFR 100.20(c), the site's physical characteristics (including seismology, meteorology, geology, and hydrology) must be considered when determining its acceptability for a nuclear power reactor.

The regulation at 10 CFR 100.20(c)(3) requires that factors important to hydrological radionuclide transport be addressed using onsite characteristics. To satisfy the hydrologic requirements of 10 CFR Part 100, the NRC staff review of the applicant's safety assessment

should verify the description of groundwater conditions at the proposed site and of how those conditions will be affected by the construction and operation of a nuclear power plant or plants of specified type that might be constructed on the site. Meeting this requirement provides reasonable assurance that groundwater at or near a proposed site will not be significantly affected by the release of radioactive effluents from a plant or plants of specified type that might be constructed on the proposed site.

The regulation at 10 CFR 100.23 requires that geologic and seismic factors be considered when determining the suitability of the site and the acceptability of the design for each nuclear power plant. In particular, 10 CFR 100.23(d)(4) requires that the physical properties of materials underlying the site be considered when designing a system to supply cooling water for emergency and long-term shutdown decay heat removal. The regulation at 10 CFR 100.23 is applicable to Section 2.4.12 of this review standard because it addresses requirements for investigating vibratory ground motion, including the hydrologic conditions at and near the site. Static and dynamic engineering properties of the materials underlying the site should be determined, including the properties (e.g., density, water content, porosity, and strength) needed to determine the behavior of those materials in transmitting earthquake-induced motions to the foundations of a plant or plants of specified type (or falling within a PPE) that might be constructed on the site.

Meeting this requirement provides reasonable assurance that the effects of a safe shutdown earthquake would pose no undue risk to the type of facility proposed for the site.

For those cases where a reactor design is not specified, the ESP applicant may instead provide a PPE to characterize a facility or facilities for comparison with the hydrologic characteristics of the site. A PPE can be developed for a single type of facility or a group of candidate facilities by selecting limiting values of parameters. Important PPE parameters for safety assessment Section 2.4 include but are not limited to precipitation (e.g., maximum design rainfall rate and snow load) and the allowable site water level (e.g., maximum allowable flood or tsunami surge level and maximum allowable ground water level).

Note: Though not required at the ESP stage, the applicant for a COL will need to demonstrate compliance with General Design Criterion 2 (Ref. 3) as it relates to structures, systems, and components important to safety being designed to withstand the effects of natural phenomena.

To meet the requirements of the hydrologic aspects of 10 CFR Part 52 and 10 CFR Part 100, the following specific criteria are used:

Safety assessment Section 2.4.12.1: A full, documented description of regional and local groundwater aquifers, sources, and sinks is necessary. (Ref. 4) In addition, the type of groundwater use, wells, pump and storage facilities, and the flow needed for a nuclear power plant or plants of specified type (or falling within a PPE) that might be constructed on the site should be described. If groundwater is to be used as an essential source of water for safety-related equipment, the design basis for protection from natural and accident phenomena should compare with Regulatory Guide 1.27 (Ref. 5) guidelines. Bases and sources of data should be adequately described and referenced.

Safety assessment Section 2.4.12.2: A description of present and projected local and regional groundwater use should be provided. Existing uses, including amounts, water levels, location, drawdown, and source aquifers should be discussed and should be tabulated. Flow directions, gradients, velocities, water levels, and effects of potential future use on these parameters,

including any possibility for reversing the direction of groundwater flow, should be indicated. Any potential groundwater recharge area within the influence of a nuclear power plant or plants of specified type (or falling within a PPE) that might be constructed on the site and effects of construction, including dewatering, should be identified. The influence of existing and potential future wells with respect to groundwater beneath the site should also be discussed. Bases and sources of data should be described and referenced. References 6 through 12 discuss certain studies concerning groundwater flow problems.

Safety assessment Section 2.4.12.3: The need for and extent of procedures and measures to protect present and projected groundwater users, including monitoring programs, must be discussed. These items are site-specific and will vary with each application.

The following guidance applies to the COL stage. To meet the requirements of 10 CFR Part 50,§ 50.55 (Ref. 13) and § 50.55a (Ref. 14); General Design Criteria 2, 4 (Ref. 15), and 5 (Ref. 16); and 10 CFR Part 100, the following specific criteria are used:

Safety assessment Section 2.4.12.4: At the COL stage, the design bases (and development thereof) for groundwater-induced loadings on subsurface portions of safety-related structures, systems, and components should be described. If a permanent dewatering system is employed to lower design basis groundwater levels, the bases for the design of the system and determination of the design basis for groundwater levels should be provided. Information should be provided regarding (1) all structures, components, and features of the system; (2) the reliability of the system as related to available performance data for similar systems used at other locations; (3) the various soil parameters (such as permeability, porosity, and specific yield) used in the design of the system; (4) the bases for determination of groundwater flow rates and areas of influence to be expected; (5) the bases for determination of time available to mitigate the consequences of system failure where system failure could cause design bases to be exceeded; (6) the effects of malfunctions or failures (such as a single failure of a critical active component or failure of circulating water system piping) on system capacity and subsequent groundwater levels; and (7) a description of the proposed groundwater level monitoring program and outlet flow monitoring program. In addition, if wells are proposed for safety-related purposes, the hydrodynamic design bases (and development thereof) for protection against seismically induced pressure waves should be described and should be consistent with site characteristics.

III. REVIEW PROCEDURES

Requirements and procedures governing issuance of ESPs for approval of proposed sites for nuclear power facilities are specified in 10 CFR Part 52. Information required for such a permit includes a description of the site's characteristics. For this type of permit, the groundwater data are reviewed as outlined below.

Section 2.4.12 of the applicant's safety assessment is reviewed to identify any missing data, information, or analyses necessary for the staff's evaluation. Applicant responses to the requested information will be evaluated using the methods outlined below, and staff positions will be developed based on the results of the analysis. Resolution, if possible, of potential groundwater problems or of differences between applicant's and staff's design bases will be coordinated through the NRR project manager, and the safety evaluation report (SER) will be written accordingly.

Local and regional groundwater conditions are reviewed by comparing the applicant's description with reports by the U.S. Geological Survey (USGS), other agencies, and professional organizations. Other NRC organizational elements with related review responsibilities will be notified of any applicable groundwater data and analyses. If onsite groundwater use and facilities are safety-related, the criteria of Regulatory Guide 1.27 are applied.

The staff will compare the applicant's description of present and projected local and regional groundwater use, existing users, including ambient use, water levels, location, and drawdown with information and data from references. Drawdown effects of projected future groundwater use, including the possibility for reversing the groundwater flow, will be evaluated and may be checked by independent calculations. Construction effects, including dewatering, on potential recharge areas may also be evaluated.

At the COL stage, the needs and plans for procedures, measures, and monitoring programs will be reviewed based upon site-specific groundwater features. Design bases for groundwater-induced loadings on subsurface portions of safety-related structures are reviewed. Independent calculations are performed to determine the adequacy of the design criteria and the capability to reflect any potential future changes which can be induced by variations in precipitation, construction of future wells and reservoirs, accidents, pipe failures, or other natural events. For dewatering systems, calculations are performed to determine phreatic surfaces, normal flow rates, flow rates into the system as a result of pipe breaks (circulating and service water system pipes), groundwater rebound times assuming total failure of the system, and system capacity.

The above reviews are performed only when applicable to the site or site region. Some items of review may be done on a generic basis.

IV. EVALUATION FINDINGS

For ESP reviews, the findings will summarize the applicant's and staff's estimates of groundwater levels and, where applicable, groundwater flow directions, gradients, velocities, effects of potential future use on these parameters, and applicability and reliability of dewatering systems. If the groundwater parameters are comparable, staff concurrence in the applicant's estimates will be stated. If the staff predicts substantially more conservative groundwater conditions and a nuclear power plant or plants of specified type (or falling within a PPE) that might be constructed on the proposed site may be adversely affected, a statement of the staff bases will be made.

A sample ESP statement follows:

> As set forth above, the proposed site lies within a groundwater region, which is part of the Piedmont Groundwater Province. Groundwater in the area is derived entirely from local precipitation. The water is contained in the pores of the residual soils and in joints and cracks of the rock. There is a north-south groundwater ridge at the area upon which a nuclear power plant would be sited, and groundwater flow is to the north, east, and west. The groundwater gradient in the plant area is about 1.8 to 2.1 m (6 to 7 ft) per 30.5 m (100 ft). Permeability is controlled by the extent and distribution of fractures in the bedrock and by the size and distribution of pores in the overlying soil. The applicant has made laboratory and field permeability tests and has determined values ranging from

zero to about 1500 m (5000 ft) per year. Measured depths from the existing ground surface to the groundwater table on the ridges range from about 12 to 24 m (40 to 80 ft). However, the plant grade would be at about existing groundwater level. The groundwater table is generally at or near the surface in valleys and draws near the site. Groundwater data for the proposed site are consistent with the groundwater level identified in the early site permit application.

Based on these considerations, the staff concludes that the above description of the local groundwater aquifer satisfies the requirements of 10 CFR Parts 52 and 100, which require that hydrologic characteristics be considered in the evaluation of the site.

V. IMPLEMENTATION

The following is intended to provide guidance to applicants and licensees regarding the NRC staff's plans for using this section of this review standard.

This section will be used by the staff when performing safety evaluations of ESP applications submitted by applicants pursuant to 10 CFR Part 52. Except in those cases in which the applicant proposed an acceptable alternative method for complying with specified portions of the Commission's regulations, the method described herein will be used by the staff in its evaluation of conformance with Commission regulations.

Implementation schedules for conformance to parts of the method discussed herein are contained in the referenced regulatory guides and NUREGs.

VI. REFERENCES

In addition to the following, references on methods and techniques of analysis, published data by Federal and State agencies, such as USGS water supply papers, will be used as available.

1. 10 CFR Part 52, "Early Site Permits; Standard Design Certifications; and Combined Licenses for Nuclear Power Plants."

2. 10 CFR Part 100, "Reactor Site Criteria."

3. 10 CFR Part 50, Appendix A, General Design Criterion 2, "Design Bases for Protection Against Natural Phenomena."

4. Regulatory Guide 1.70, "Standard Format and Content of Safety Analsysi Reports for Nuclear Power Plants."

5. Regulatory Guide 1.27, "Ultimate Heat Sink for Nuclear Power Plants."

6. "Finite Element Solution of Steady State Potential Flow Problems," HEC 723-G2-L2440, Corps of Engineers (1970)."

7. T. A. Prickett and C. G. Lonnquist, "Selected Digital Computer Techniques for Groundwater Resource Evaluation," Bulletin 55, Illinois State Water Survey, Urbana, Illinois (1970).

8. D. B. Cearlock and A. E. Reisenauer, "Sitewide Groundwater Flow Studies for Brookhaven National Laboratory, Upton, Long Island, New York," Battelle Pacific Northwest Laboratories, Richland, Washington (1971).

9. K. L. Kipp, D. B. Cearlock, A. E. Reisenauer, and C. A. Bryan, "Variable Thickness Transient Groundwater Flow Model--Theory and Numerical Implementation," BNWL-1703, Battelle Pacific Northwest Laboratories, Richland, Washington (1972).

10. D. R. Friedrichs, "Information Storage and Retrieval System for Well Hydrograph Data--User's Manual," BNWL-1705, Battelle Pacific Northwest Laboratories, Richland, Washington (1972).

11. K. Kipp and D. B. Cearlock, "The Transmissivity Iterative Calculation Routine--Theory and Numerical Implementation," BNWL-1706, Battelle Pacific Northwest Laboratories, Richland, Washington (1972).

12. D. L. Schreiber, A. E. Reisenauer, K. L. Kipp, and R. T. Jaske, "Anticipated Effects of an Unlined Brackish-Water Canal on a Confined Multiple-Aquifer System," BNWL-1800, Battelle Pacific Northwest Laboratories, Richland, Washington (1973).

13. 10 CFR Part 50, § 50.55, "Conditions of Construction Permits."

14. 10 CFR Part 50, § 50.55a, "Codes and Standards."

15. 10 CFR Part 50, Appendix A, General Design Criterion 4, "Environmental and Dynamic Effects Design Bases."

16. 10 CFR Part 50, Appendix A, General Design Criterion 5, "Sharing of Structures, Systems, and Components."